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The Natural Resource Curse: An Analysis of the Dutch Case Based on Sectoral Economies of Scale

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Abstract

This paper analyzes the curse of natural resources from a new approach, taking as reference object the economy of the Netherlands. It is shown how the deindustrialization process of an economy suffers as a result of the natural resource sector development, and how it may cause lower growth rates when the industrial sector has certain features. As a starting point, we proceed with an estimation of production functions for different sectors of the economy in order to quantify the economies of scale in each of them. Subsequently, by means of a constrained optimization model, a boom in the natural resource sector is simulated and the results obtained under different scenarios are discussed by comparing them with a base scenario. The results obtained suggest that the curse of natural resources can occur if the expansion of the natural resource sector is high, in this case being the lower economic growth rate. This curse could be mitigated by expanding the areas of high productivity in non-tradable goods. It is also noted that the higher the labour market rigidity the result it will be a lower economic growth rate, and a combination of these rigidities with a pronounced expansion in the resource sector could lead to further reductions in economic growth rates.

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1. Introduction

The curse of natural resources is a controversial and paradoxical issue that has gained increasing economic importance, especially in developing countries. When we speak of the curse, we are dealing with a difficult to understand special situation where the resource-rich countries are those with poor economic development. Many questions arise: How does an economy that is endowed with rich natural resources experience a lower rate of development, while others less rich show an accelerated rate of growth? How is it that countries rich in natural resources are not rich in economic terms, when the whole production process requires basic raw materials and energy? If a significant endowment of natural richness and an infinite demand for products derived from this are not sources of further growth, what then are the necessary resources for further growth?

It is really difficult to find a clear explanation for the natural resource curse, though a variety of arguments or trying to justify this phenomenon exist. From the economic point of view, the most popular explanation with greater empirical support is based on the Dutch disease. The concept of Dutch disease was coined after the experience of the Netherlands in the 1960s when the discovery of natural gas reserves in the North Sea took place. This finding led to both an expansion of the energy sector and a deindustrialization of the economy that ultimately led to a recession.

Following this explanation, several theoretical models that have added interesting variables to the study of the curse such as the level of human capital, the existence of externalities and the institutional quality of countries began to emerge. However, few studies have tried to explain the underlying causes of the relationship between industrialization and economic growth.

The purpose of this paper is to contribute to the study of the natural resource curse within the scope of the relationship between industrialization and economic growth. To this end, as an initial hypothesis we pose the possibility that each sector of the economy follows their own dynamics as a result of the innovation and absorption process as well as those complementarities belonging to their firms, industries and to the same sector against other economic sectors. Basically, these dynamics are determined by different types of economies of scale: internal and external to firms.

To attribute the curse of natural resources being due to the Dutch disease, the industrial sector should contain more relevant economies of scale than the natural resources sector. If this is true, the industrial sector contraction that occurs as a result of the expansion of the natural resource sector will decrease the potential economic growth at aggregate level, generating lower growth rates, leading, therefore, to the natural resources curse.

By studying the case of the Netherlands, we will prove that the industrial sector has economies of scale which are more important than the booming sector, resulting in lower growth rates. The Netherlands is an especially interesting case due to its historical importance in the explanation of the natural resource curse, their statistics showing that the dynamic explained through the basic model of the Dutch disease is still applicable, which makes it an appropriate setting to test the working hypothesis.

In addition to these historical reasons, the behaviour of the Dutch economy continues reflecting to this day the dynamic explained through the Dutch disease. This gives us on adequate environment to simulate a natural resource boom and assume that the dynamic actually referred to by the basic model of the disease could be realized.

For this purpose, we will use two different methodologies. First, we will estimate production functions for each of the activity sectors so that the economies of scale in each of the sectors will be quantified. Then, we will develop a constrained optimization model that incorporates the movements in the labour force across sectors to simulate a shock in the natural resources sector, in order to assess its effects on the growth rate of the economy and to compare the results with a base scenario.

The present study is divided into five sections. After this brief introduction, the second section presents an overview of the existing economic literature on the issue. The third section contains the empirical methodology to be used in order to carry out our analysis, and the fourth shows the main results. Finally, the fifth section presents the main conclusions drawn from the study and some suggested ideas to go deeper into this issue in future research.

2. The Curse of Natural Resources.

The term natural resource curse refers to a general trend to exhibit lower rates of economic growth in those countries with large natural resource endowments or experiencing positive shocks in endowments or in the relative prices of natural resources, comparing them with other countries without natural resources. The main explanation lies in the phenomenon known as the Dutch disease, which takes its name from the effects attributed to the Dutch manufacturing sector due to the gas discovery in the North Sea. It is expected that a positive shock in the natural resource sector of a country causes a reallocation of its productive factors, focusing on those economic activities that benefit from this shock and tending to a decrease in the industrial sector. At the same time there would be a currency appreciation and a loss of international competitiveness.

A good explanation of the process that occurs because of the natural resource boom is put forward by Stijns (2003) using the basic model of the Dutch disease presented by Corden (1984). This model considers a small open economy that produces three types of goods: two tradable goods whose price is determined exogenously in the international market and a third non-tradable good whose price is determined by the domestic market through the balance between supply and domestic demand. It is assumed that capital in economy is a fixed factor, whereas work is a mobile factor. In this context, a positive shock to the natural resources sector will produce two effects: a *movement effec*t and a *spending effect*.

The first effect takes into account the changes in supply, so that when the boom in the natural resources sector occurs there is an increase in the marginal productivity of labour in that sector. As a result, the marginal cost of the sector is reduced and there is a shift in the supply curve of these goods. This causes a growing labour demand in the sector, generating a transfer from the non-tradable goods sector and from the industry sector to the booming sector as well as raising wage pressures in the whole economy. Upon this wage increase there is an increase in production costs for all types of goods, although in a small open-economy context, there is only an increase in the prices of non-tradable goods, appreciating the real exchange rate.

The spending effect takes into account the changes on the demand side. The boom in the natural resource sector produces an increase in revenues as well as an increase of the demand for all goods in the economy. As the price of tradable goods is set on the international market, the rise in demand affects only the relative price of non-tradable goods by increasing it, causing again an appreciation of the real exchange rate. This process produces, in turn, a movement of the labour force from the tradable goods sector to the non-tradable one.

The industrial sector would be part of the tradable goods group, so it would experience a reduction. Stijns (2003) identified as direct deindustrialization the movement from the manufacturing sector to the booming one, and as indirect de-industrialization the movement of factors outside the non-tradable sector combined with an increased demand for these sector goods due to the spending effect, which generates a transfer of labour from the manufacturing sector to the non-tradable one[3].

The works of Rodriguez and Sachs (1999) and Sachs and Warner (2001) are among the most significant ones on the natural resource curse; they refer to the negative relationship between natural resource endowment and the rate of production growth. Their results support the view that there are certain key industries within the manufacturing sector which are of great importance to the endogenous growth of a country.

Stijns's work (2003) proves the existence of the Dutch disease regardless of its effect on growth rates, without discussing the implications of the deindustrialization process by means of a gravity model of trade. Collier and Goderis (2007) obtain empirical evidence by using cointegration techniques with panel data, noting that a natural resource boom has positive effects on the level of production in the short term but has adverse effects in the long term.

Studies that allude to other key factors are those of Bravo-Ortega and De Gregorio (2005), Gylfason (2001), Murshed (2004) and Stijns (2006). Bravo-Ortega and De

[3] Stijns (2003) states that we can expect the indirect deindustrialization to be more important than the former one, depending on the propensity to consume services (non-tradable goods). This situation occurs more often when the State obtains substantial resources through the income derived from natural resources.

Gregorio (2005) develop a theoretical model able to explain how a high level of human capital can reduce the effect of the natural resource curse, testing this hypothesis by using data for several countries. Gylfason (2001) obtained similar evidence for a sample of countries and Stijns (2006) studies the link between natural resource abundance and human capital accumulation. Murshed (2004) studied the role of institutions in the natural resource curse, noting that different types of resource endowments (minerals, oil, coffee, cocoa, etc) have different effects on institutional quality.

Mehlum, Moene and Torvik (2006) establish a theoretical model which explains the influence of institutional quality on growth rates of an economy with an abundance of natural resources. According to this model, quality institutions can promote productive activities to the detriment of resource hoarding. Using data on institutional quality, they note that those countries with poor institutional quality are the most likely to suffer the natural resource curse.

By using the VAR methodology, Hutchinson (1990) studies the cases of Norway, the United Kingdom and the Netherlands, reaching the conclusion that the prediction of a contraction in the industrial sector is valid in the short term, but in the long term there is no evidence that prolonged boom effects will have adverse effects on growth. Guidi (2009) uses a similar methodology for the study of the oil boom in the United Kingdom, identifying a positive relationship between increasing the oil prices and manufacturing and services output and a negative relationship regarding salaries in both sectors.

Finally, Olusi and Olagunju (2005) apply the VAR methodology to the case of Nigeria, confirming the existence of the Dutch disease. Unlike other works, these authors did observe that the effects of the disease are latent over the long term, contracting the agricultural sector rather than the manufacturing one.

3. Empirical Methodology

To conduct the empirical analysis we will first proceed to analyze the sectoral dynamic, including an analysis of both, the processes of innovation, learning and diffusion and the complementarities, in order to determine which sectors have a higher growth potential. The concept underlying the analysis of the sectoral dynamics is the one regarding the economies of scale: internal to the firm, urbanization and agglomeration economies and dynamic economies. We will discuss about the natural resource curse resulting from the deindustrialization process when the sectors that are reduced as a consequence of the boom enjoy a higher growth potential than those sectors that are expanding.

The sequence of steps to follow will be: (i) to analyze the dynamics of each sector (economies of scale) through a measurement methodology; (ii) to observe the behaviour of each sector when facing expansion or contraction in activity levels, and their contribution to overall economic growth, and (iii) to simulate a shock in the natural resource sector under alternative scenarios and measure the response of the economy at aggregate level will be measured, comparing the obtained results with a base scenario.

To simplify the analysis, the activity sectors regarding the SITC classification will be grouped as follows: (i) Agriculture, Hunting, Forestry and Fisheries (A + B); (ii) Mining, Quarrying and Energy Supplies and Water (C + E), Manufacturing (D), Construction (F), Business Services (G-K), Public Administration, Defence and Social Security (L) and Education, Health, Social Work and Community and Domestic (M-P)[4].

3.1. Measuring economies of scale

To clearly define economies of scale it is necessary that they take into account innovation processes and complementarities as well as the concepts that are derived from them: absorption, learning, diffusion and back and forth links. Iturribarría Perez (2007) identifies three types of economies of scale: internal; of localisation; and of urbanization.

Internal economies of scales arise from the existence of certain costs which are indivisible or fixed costs being independent of the production volume and of the production facility placement. Thus, the increased volume production allows costs to be distributed among a greater number of goods, reducing the cost of production per unit, and resulting in an increase in internal returns to the company.

Economies of localization or agglomeration are derived from the causes set forth by Marshall as the formation of a concentrated labour market, the development of an input supplier sector and specialized services, and the increased communication and information flow that is generated. Together with these factors, the cost reduction that

[4] Table 1 in the Appendix shows the classification of the SITC activity sectors

results from a better organization between firms, such as transport costs, negotiation and transaction should be taken into account. According to Ocampo (2008) the technological osmosis can generate externalities due to the information and human capital that is spread among industry companies. In these cases, companies can reduce their production costs when establishing in areas with a high concentration of firms dedicated to producing the same goods, or using similar production processes, being external to the firms but internal to the industry.

When dealing with urbanization economies, companies achieve benefit from the diversity of the environment due to the special importance assumed by the processes of innovation and diffusion of ideas among companies from different industries and activity sectors. The market size also acts as a potential source of agglomeration economies, as Krugman (1997) points out, placing the companies where the market potential is greater, locating the largest markets where more companies are set. Such economies are external to firms and external to the industry.

Finally, the last type to be considered are dynamic economies, referring to the stock of information or knowledge accumulated over the years and concerning all aspects of the know-how business. These mean reductions in production costs related to the learning process derived from the production structure.

In order to measure all the externalities mentioned above, we will proceed to estimate production functions by industries, as done by Iturribarría Pérez (2007). The production function will try to collect effects derived from the intra-company income (internal economies of scale) and extra-company income (agglomeration economies, urbanization, dynamics and complementarities). Our production function will be like this:

$$Y = \alpha(r,\pi) * i(q) * e(\phi, u, q_t, c) * f(K, L)$$

where $\alpha(r,\pi)$ is an innovation factor that depends on the associated risk, r, which in turn depends on macroeconomic stability and π is the ability to appropriate the benefit from such innovations. $i(q)$ is a function that contains the internal economies of scale of each company and is directly dependent on the output level *q*. In turn, the term $e(\phi, u, q_t, c)$ contains the returns to scale that depend directly on the industry concentration level, ϕ, i.e., agglomeration economies, the market size and the urban development (u) and the dynamic economies. The term q_t contains the production accumulated over the years, representing the sector's production experience, and c is a measure of complementarities between firms, industries and sectors. The term $f(K,L)$ is the traditional production function with constant returns to scale, since the increasing returns are derived from the first part.

Given the availability of existing data, this paper will be limited to measuring the impact of returns to scale arising from agglomeration economies, urbanization, internal scale economies and dynamic economies. Measurement of complementarities and the impact and diffusion of innovations will remain pending for future research[5].

We need to find statistical variables that approximate these effects with the level of disaggregation required. For this purpose we can take as reference the work of Krugman (1998) which shows the idea of centripetal and centrifugal forces that affect the geographic concentration of economic activities and markets. According to these ideas, the external economies of agglomeration arise where there is a significant concentration of a specific industry, tending to be concentrated in specific geographic areas rather than being evenly dispersed throughout the country. In turn, we can approximate the level of concentration of an industry by means of the population employed by this industry. If we are really dealing with economies of agglomeration, the relationship between the industrial output growth and the concentration of a sector or industry in a given territory should be positive. As a variable, we can use the Herfindahl-Hircshman (HHI) index which will indicate the degree of concentration or diversity. As well as measuring agglomeration economies, this index can help us to observe the presence of urbanization economies, adopting a negative sign in this case.

The HHI for a sector i is calculated as the sum of the squared ratios between the employed population in each sector (except i) and the total employed population.

In economies of urbanization, the diversity of activities together with the market size generate economies of scale. In the event of such economies we would expect a

[5] For such measurements we would need to have disaggregated information at the level of four digits in the SITC and additional information on research and development, foreign participation in domestic industries, and statistics on Foreign Direct Investment disaggregated by regions and activity sectors.

direct relationship between growth in the production level of an industry and the population employed in other industries. A proxy variable for this type of externality is the population employed in other activities, expecting a positive sign if there are such externalities. However, this variable could also be measuring the existence of complementarities in demand.

To capture the effect of internal economies, and as we do not know exactly the size and production volume of each firm, we should try to approximate it. We can use the average size of local units (company size, TE) from the ratio between the number of positions or jobs (POP) by the number of productive units (UL) that exist in each considered region. If the variable is appropriate it should reflect the existence of increasing returns to scale (internal to the firm), obtaining a positive sign in its coefficient.

Dynamic economies would also be of interest, since the patterns of specialization of the past can define different growth paths. To capture these effects Callejón and Costa (1996) propose two variables: the population employed in the sector or industry of interest (in logs), and a measure of specialization in that sector (ESP) which is calculated as the ratio between the employed population in this industry or sector and the total employed population. A variable in levels may be capturing specific dynamics for a region. If there are such externalities we would get a positive coefficient on both variables.

To approximate the effects of innovations, and the human capital tied to them and the processes of diffusion and learning, it is of interest to include variables that take into account the level of spending on education and on research and development. Authors such as Romer (1993) and Iturribarría Perez (2007) propose using variables such as Foreign Direct Investment, Machinery Import and Foreign Participation in Domestic Firms, but these data are not available at the necessary level of disaggregation to be included in this paper. We have finally decided to use the rate of school attendance and the spending on research and development as a percentage of GDP.

Finally, it is necessary to include two sets of control variables. The first group would consist of two variables: average compensation to production factors (COMP) and the formation of fixed assets (FAF) by sector and region. The second set of control variables consists of three binary or fictitious variables, each associated to a geographical area: West (W), East (E) and South (S), leaving the northern region as a basis for relevant comparisons.

Including all the variables mentioned above, multiple linear regressions will be estimated by ordinary least squares. Three equations will be estimated for each sector of activity:

$$(1)\ \ln\left(AV_{pe}\right)_i = \beta_0 + \beta_1(POP_T - POP_i) + \beta_2 HHI_i + \beta_3 \ln(TE_i) + \beta_4 ESP_i + \beta_5 EMP_i + \beta_6 \ln(FAF_i) + \beta_7 \ln(COM_i) + \varepsilon_i$$

$$(2)\ \ln\left(AV_{pe}\right)_i = \beta_0 + \beta_1(POP_T - POP_i) + \beta_2 HHI_i + \beta_3 \ln(TE_i) + \beta_4 ESP_i + \beta_5 EMP_i + \beta_6 \ln(FAF_i) + \beta_7 \ln(COM_i) + \beta_8 EDU_T$$
$$\beta_9 RD_T + \varepsilon_i$$

$$(3)\ \ln\left(AV_{PE}\right)_i = \beta_0 + \beta_1(POP_T - POP_i) + \beta_2 HHI_i + \beta_3 \ln(TE_i) + \beta_4 ESP_i + \beta_5 EMP_i + \beta_6 \ln(FAF_i) + \beta_7 \ln(COM_i) + \beta_8 EDU_T$$
$$\beta_9 RD_T + \beta_{10} W + \beta_{11} E + \beta_{12} S + \varepsilon_i$$

The first equation incorporates the effects of all types of economies of scale that we want to identify plus two control variables related to wages and fixed asset formation. The second equation includes, in addition to the first, the effects of Education and Research and Development as control variables. Finally, equation (3) includes dummy variables for geographic areas.

Table 1 shows the names of each of the variables used in the process to measure economies of scale, along with a brief description and their method of calculation as well as the year for which data are available and the sources used to obtain them.

Table 1: Variables used in the analysis

Name	Description	Year	Source
AV_{pe}	Aggregate value per person employed in the activity sector *i*.	2007/1996	CBS (Statistics Netherlands)
$POP_T - POP_i$	Difference between the total employed population and the population employed in industry *i* by region and activity sector. Occupancy data are measured in fte.	2007/1996	CBS (Statistics Netherlands)
HHI_i	Herfindahl-Hirchsman Index calculated from employement data in fte by region and activity sector	2007/1996	CBS (Statistics Netherlands)
$\ln TE_i$	Average size of local units by region and activity sector calculated as the ratio between the employed population and the number of local units (in logs)	2007/1996	CBS (Statistics Netherlands)
ESP_i	Specialization measure by region and sector of activity measured as the ratio between the employed population in the sector *i* and the total.	1997	CBS (Statistics Netherlands)
$\ln EMP_i$	Population employed in the sector *i* by region and sector of activity (in logs)	1997	CBS (Statistics Netherlands)
$\ln AAF_i$	Formation of fixed assets per employee by region and activity sector. It is calculated by the ratio between total compensation of each sector and the employed population in this sector (in logs)	2007/1996	CBS (Statistics Netherlands)
$\ln COM_i$	Compensation to the factor per employee by region and activity sector. It is calculated by the ratio between total compensation of each sector and the employed population in this sector.	2007/1996	CBS (Statistics Netherlands)
EDU_T	Percentage of students in all levels of education with respect to the total population (by province)	2007	Eurostat
$R\&D_T$	R & D expenditure as a percentage of GDP (by province)	2007	Eurostat
W	West Region	2007	CBS (Statistics Netherlands)
E	East Region	2007	CBS (Statistics Netherlands)
S	South Region	2007	CBS (Statistics Netherlands)

3.2. *Simulation procedure.*

Once sectoral dynamics have been estimated, we can proceed to simulate a shock in the natural resources sector to assess its effects on the growth rate of the economy as a whole and to compare the results with a base scenario. To perform simulations, we need to define alternative scenarios so as to illustrate the booming situation and a methodology that allows us to overlap different scenarios and get aggregate growth rates. To this end a constrained optimization model is proposed.

Our first step will be, therefore, to define the different scenarios: the one conforming to the boom of the natural resources sector, and the base or reference scenario. The aim of defining this last scenario is to calculate the reference rate upon which we can make comparisons. Other scenarios will result in restrictions in the optimization model.

3.2.1. Alternative scenarios

As a starting point we will consider both a theoretical scenario and a more realistic one. The difference between them is that the first assumes perfect mobility of the labour factor on the assumptions of the Dutch disease model. The more realistic scenario assumes that there are certain restrictions on the mobility of people and therefore there will be a percentage of restrictions that, in the short term, will have a fixed nature.

Another distinction we will assume is the one related to the relative boom importance, measuring it through the amount of the labour factor that will attract the natural resource sector. We will consider three possibilities for the increase in the employed population in the sector: 1%, 10% and 20%.

Finally, another important distinction consists of considering three parallel situations concerning the behaviour of the non-tradable goods sector: (i) there is no change in its activity level; (ii) it is undergoing an expansion, and; (iii) it is undergoing a contraction.

As a base scenario we have used data covering the period 1996-2007 in order to calculate the average annual growth rate, the reason being that choosing this period we avoid having as a reference a year of recession or expansion of the economy. We have, by combining all data, a total of 19 scenarios (18 alternatives and 1 base).

3.2.2. Optimization model

The optimization model, with which we are going to deal, aims at testing that the natural resource curse is feasible when certain activity sectors contract as a result of the expansion of others. Therefore this model should show the maximum potential growth of an economy under different circumstances, so that when a shock occurs in the natural resources sector its maximum decreases and it is below the one existing in the base scenario, when thus we can say that the curse is feasible.

The model proposes the maximization of the growth rate of the economy subject to a specific allocation of the labour factor derived from the natural resources sector boom. The control variable of the problem will be the number of employed persons assigned to each region COROP[6], so that the allocation to be carried out will be the most efficient one (maximizing the country's growth rate), considering the restrictions imposed by the alternative scenarios.

Starting from the three equations proposed in the previous sub-epigraph at a sectoral level, we can obtain the growth rate of the economy as a whole by using the values of the estimated coefficients. Our objective function would be defined as follows:

$$(1) Max\ \lambda_t = (1/n)\sum_{i=AB}^{MP}\ \sum_{j=1}^{40} g_{ij,t} * \left(\frac{AV_{pe_{ij,t-1}}}{AV_{pe_{T,t-1}}}\right)$$

where λ_t is the country's growth rate in period *t*. The sub index *i* refers to each of the sectors of the economy activity that have been considered in the analysis of economies of scale (A + B, C + E, D, F, GK, L and MP). The sub index *j* refers to each of the regions COROP in which the Netherlands are divided, being $g_{ij,t}$ the growth rate experienced by the sector *i* in region *j* for the period *t*. AV_{pe} refers to the aggregated value per employed population and *n* is the number of years used to calculate the average annual rate (11 years, 1996-2007).

The growth rates of each sector and each region can be obtained from the data at the aggregate level for the year 1996 (base year) and from the results obtained from the proposed equations estimation.

$$(2) g_{ij} = \ln(AV_{pe_{ij,t}}) - \ln(AV_{pe_{ij,1996}})$$

$$(3) \ln\left(AV_{pe}\right)_{ij} = \beta_{0i} + \beta_{1i}(POP_T - POP_{ij}) + \beta_{2i}HHI_i + \beta_{3i}\ln(TE_{ij}) + \beta_{4i}ESP_{ij} + \beta_{5i}EMP_{ij} + \beta_{6i}\ln(AAF_{ij}) + \beta_{7i}\ln(COM_{ij}) + \beta_{8i}EDU_T + \beta_{9i}RD_T + \beta_{10i}W + \beta_{11i}E + \beta_{12i}S + \varepsilon_i$$

Combining the three previous expressions; we obtain the rate of economic growth that forms the objective function to maximize. The control variables will be the populations that are allocated to the sector of interest: the natural resource sector when

[6] Regional division in the Netherlands based on the Coordination Comission Regional Research Programme (COROP) which includes a total of 40.

simulating the boom, POP_{CE}, and non-tradable sectors when simulating an expansion, POP_{MP}. Note that the control variables are present in two of the variables used in the estimating equations.

The simulation that we propose has its limitations and we think it is appropriate to give more details. As the model sets out the rate of change resulting from the reallocation of the labour factor in the short term, it is logical to maintain constant the capital factor and the variables of Education and Research and Development. The variables related to the dynamic economies could not have major changes to the extent that changes are observed taking place at the precise moment of the shock.

But there are other variables that do change and that the model does not take into account. One of them covers the wages in each sector. Even if one assumes that the conditions exist to make all wages equal in all sectors, the regression results indicate that there are sectors that respond more strongly than others. The limitation has to do with the initial expansion of the natural resource sector products, which is not included in the simulation; the expansion generates an increase in the sector's relative weight in the economy and produces variation rates that are much higher. The final limitation of the objective function is related to firm size. The quantity of labour factor allocated in the short term to a particular sector should be directly related to the size of the productive establishments and that variation would not be captured.[7].

Having defined the limitations of the simulation we proceed to set out the different restrictions. The first one is general for all possible scenarios and implies that the total employed population must remain the same as in the beginning. This restriction implies the assumption that the economy is in equilibrium with full employment and, even though the process of deindustrialization occurs, it is in equilibrium with full employment.

$$(4)\ \mathrm{POP_T} = \sum_{i=AB}^{MP}\sum_{j=1}^{40} POP_{ij}$$

[7] As seen below when dealing with results, the problem is much smaller in this last point when the natural resource sector and the non-tradable one present decreasing returns to scale. This implies that in the case of a boom, growth rates would be even lower. Therefore, if positive results are obtained with this model, a more realistic one incorporating variation in firm size should have better results.

The following restrictions illustrate the expansion of the natural resources sector (C + E) and the contraction of the industrial sector (D).

$$(5)\ \mathrm{POP}_{\mathrm{CE,j}} = \mathrm{POP}^{\mathrm{b}}_{\mathrm{CE,j}} * (1 + EXP)$$

$$(6)\ \mathrm{POP}_{\mathrm{D,j}} \geq \mathrm{POP}^{\mathrm{b}}_{\mathrm{D,j}} * (RIG)$$

$$(7)\ \mathrm{POP}_{\mathrm{D,j}} \leq \mathrm{POP}^{\mathrm{b}}_{\mathrm{D,j}}$$

The superscript b refers to the value of the variable in the base scenario, while the other variables are the result of the optimization process. The EXP expression shows the percentage of expansion in the sector concerned and the term RIG refers to labour market rigidities (percentage of employed population that is immobilized in the workplace). The restriction (5) is formulated so that the increase caused by the boom takes place in all regions and in equal proportion. This means that the most productive regions do not benefit the most, as common sense would indicate, but all of them experience an increase to a certain percentage.[8]

If you look closely at the expression (7), it can be seen that its intention is to prevent reallocations within the sector itself. The restriction (6) captures the rigidities in the labour market and it is more logically related to reality in the sense that labour market rigidities are widespread throughout the country, and all productive sectors are subject to similar conditions.

When solving the optimization problem there are limits regarding the amount of control variables, in not being able to simulate the expansion of the natural resource sector at the same time as the expansion / contraction of the non-tradable sector. To solve this problem, the procedure to follow will be divided into two stages: the first includes the expansion of the natural resources sector, and the second the expansion / contraction of the non-tradable sector. To do it this way it will be necessary to impose 6 additional restrictions, so that the constraints from (8) to (10) together with equations

[8] This has been done with the intention of simplifying the model. The first tests adopted an inequality restriction intended to allow the C + E sector to grow far as possible so as to maximize the rate of economic growth with further expansion of the sector, without the appearance of the term EXP in the expression (5). In this context the optimal result was that the natural resources sector does not expand, even in those more productive regions.

from (1) to (4) form the first stage, while restrictions from (11) to (14) together with equations from (1) to (4) comprise the second stage in the case of a contraction in the non-tradable sector.

$$(8)\ \mathrm{POP}_{\mathrm{MP,j}} \geq \mathrm{POP}^{\mathrm{b}}_{\mathrm{MP,j}}$$

$$(9)\ \mathrm{POP}_{\mathrm{D,j}} \geq \mathrm{POP}^{'}_{\mathrm{D,j}} * (RIG)$$

$$(10)\ \mathrm{POP}_{\mathrm{D,j}} \leq \mathrm{POP}^{'}_{\mathrm{D,j}}$$

$$(11)\ \mathrm{POP}_{\mathrm{CE,j}} \geq \mathrm{POP}^{'}_{\mathrm{CE,j}} * (1 + EXP)$$

$$(12)\ \mathrm{POP}_{\mathrm{MP}} \geq \mathrm{POP}^{\mathrm{b}}_{\mathrm{MP}} (RIG)$$

$$(13)\ \mathrm{POP}_{\mathrm{MP,j}} \leq \mathrm{POP}^{\mathrm{b}}_{\mathrm{MP,j}}$$

These 13 equations comprise the constrained maximization model of growth rates in an economy. For the simulations we will take into account the alternative scenarios that have been previously defined, and these will be completed with different values for the parameters RIG and EXP.

4. Empirical evidence.

To conduct the empirical analysis we will use data from different geographical areas of the Netherlands in two years: 1997 for dynamic economies and 2007 for the rest of the data.

Regarding the analysis of agglomeration and urbanization economies, we need to select geographic areas as small as possible. In the case of the Netherlands the following divisions are available: 4 regions, 14 provinces, 40 COROP regions and 51 municipalities. We cannot reach the maximum level of disaggregation because industrial and sectoral data are not available, but we can cover the study at the COROP level.[9]

[9] Appendix Table 2 shows the regional division as well as a definition of the variables used.

With regard to the selection of 2007 as the reference year for the study, it is noteworthy that, despite the international context not seeming the most appropriate, it is the year in which there are more available data. In fact, there are some restrictions of information with respect to the variable of fixed asset formation, which is not available for all levels of economic activity due to confidentiality reasons; these restrictions are necessary to join two sectors to avoid losing data. All these restrictions have eventually led to limiting the disaggregation to the 7 sectors indicated above.

From 2002 onwards data on the fixed asset formation concerning the manufacturing sector (D) are not available, so we made an estimation based on the historical average calculating the relative weight of sector D in the fixed asset formation of each COROP region for the period 1995-2001.

With reference to the data on educational level and research and development, we have found only statistics with provincial disaggregation, making it necessary to extend the provincial averages for the various COROP regions that make up each province. There are no disaggregated data by activity sector, which implies that the data at the provincial level will be used for all sectors in each of the estimates.

Finally, data from the average firm size are available only from 2006, which has been a serious limitation when selecting the year of study; the year 2007 has been used since there is no information about R & D in 2006.

4.1. Economies of scale

We introduce now the results derived from estimating the three models proposed in the previous section for each sectoral group.

Agriculture, Hunting, Forestry and Fisheries (A+B)

The results obtained show that in the economic sectors A and B there are agglomeration "diseconomies". The coefficient obtained for the HHI variable is always positive and statistically significant. As we mentioned before, this HHI sign may also be reflecting urbanization economies, whether derived from diversity itself, non-concentration, or from complementarities of demand regarding market size. This latter interpretation seems to be the most appropriate for the case. A decrease in the degree of concentration of these activities generates an increase in the growth rate of aggregated value per person employed close to 4.27%.

Regarding the control variables used to estimate the second model, the formation of assets, the variable of education, and the research and development one are significant, although the latter shows an opposite sign to that expected. The regional dummies indicate the existence of some delay in the west and south, with respect to the north.

Mining, Quarrying and Energy and Water Supply (C+E)

The activity sectors C and E show, initially, two interesting results in terms of returns to scale. One associated with the returns within the companies themselves, and the other on dynamic economies. In the first case, the coefficient of the average firm size has a negative sign and is statistically significant.

The negative sign that takes the variable Ln (TEI) is indicative that there are decreasing returns to scale within companies in sectors C and E. According to the results obtained in the third model, a 1% increase in the average size of companies in these sectors would lead to a reduction of about 0.63% of the *AV* growth rate of the same activity sectors.

The second interesting result is presented by the variable Ln (EMP), with a positive sign, indicating the likely existence of dynamic economies. When adding the third model, the dummy variables for dynamic economies lose significance. This loss of significance could be due to the population variable, which refers to 1997, so it was not actually capturing dynamic economies but rather territorial effects.

Regarding the control variables used, only the factor compensation is significant in the three estimated models.

Manufacturing (D)

The manufacturing sector D exhibits two coefficients related to the returns to scale that keep a high level of significance. The first is related to urbanization economies, showing a positive sign. The positive sign of this coefficient indicates that there are urbanization economies in the manufacturing sector.

The fact that the HHI variable does not present statistical significance seems to rule out the idea that these economies are due to the transfer of information across sectors. It is more plausible, therefore, that these positive externalities result from the existence of complementarities of demand and from the market size. Unlike the economies of scale explained in the sub / epigraphs above, for this variable the proposed models do not suggest a constant elasticity but rather depend on the current population. The larger the population, the greater is the elasticity of urbanization economies. Looking at the results of the third model, the elasticity of the AV_D with respect to POP_T-POP_D would be less difference for the COROP region between the total working population and the one employed in sector D (Delfzij) of 0.014, while for the COROP region, with a greater difference between its populations (Groot-Amsterdam) it would be 0.881. This means that in Delfzij an increase of 1% of this population difference would generate an increase of about 0.014% of the AV_D in the region, but in Groot-Amsterdam the increase of the aggregated value per person employed in sector D would be 0.881% given a population growth in the same proportion as in the previous region.

The second result showing statistical significance is the coefficient indicating the existence of dynamic economies. Surprisingly, its sign is negative, and the control variables used in the second and third models only reinforce the robustness of this result. The explanation of the existence of specific geographic effects is therefore discarded as in the case of sectors C and E.

A likely explanation could be that the variable Ln(EMP) is positively correlated with the number of industries within sector D, and not with a greater number of people employed in just a few industries of the same sector. This could indicate that in areas where sector D was more diversified, i.e. where there were a greater number of industries within the sector, information spillovers were reduced, or may have even been lost. This is consistent with the destruction of the learning process, and could be a cause for these so-called dynamic "diseconomies". The counterpoint to this is the existence of dynamic learning economies derived from specialization; however, the coefficient ESP_D is not significant in any of the three models. This explanation would also be consistent with what we have proposed here, this is that the ESP_D variable probably measures the degree of intersectoral specialization and intrasectoral specialization, being in the latter category where dynamic economies would arise, if the outlined explanation is adequate.

Regarding the control variables, both the formation of fixed assets and the compensation to the factors show positive signs in the coefficients as well as statistical significance for all three models. They respond firmly to what was expected and they even help to discard those initial fears about the lack of information on fixed assets. As for the other control variables used, none are significant and they do not alter the results of the remaining variables, or contribute significantly to increase the explanatory power of the model as evidenced by observing the adjusted R-squared.

Construction (F)

With reference to the construction sector, none of the proposed models present interesting results in terms of economies of scale. Only the control variable concerning the compensation paid to the factors appears as statistically significant in all regressions. However, what is striking is that sector F is the one that seems to meet the most intrasectoral homogeneity so a fairly high R2 would be expected; instead, however, the three econometric models in this sector are those with the least explanatory power of all the raised models.

To solve this problem new econometric specifications for sector F have been made. We have first added the same compensation and asset formation variable but squared, and then interaction terms between regional dummies and those related to economies of scale are used. In the ANOVA the achieved model[10] has a p-value of 0.024 (statistic F = 2.501) a little higher than the original model whose p-value was 0.002 (statistic F = 4.195), but with a R^2considerably higher

With regard to economies of scale, the new specification presents just one significant result, and would indicate the existence of dynamic economies in two of the four regions. Interaction terms between dynamic economies and the east and west regions have positive coefficients, and they are statistically significant even in the presence of control variables.

[10] We tested 8 different models by successively adding variables squared and interaction terms for each of the economies of scale. Of them all, the model presented is the one that achieved a higher R2. The other models are not shown in this paper to save space but are available upon the reader's request.

These positive coefficients imply that there are dynamic economies only in the east and west regions of the country. An elasticity of 0.02. would correspond to the first one. A 1% increase in population concerning the working population in F would nowadays have a dynamic effect (within 10 years) on the added value growth rate per person employed in the sector of 0.02%. To the west region the elasticity is higher, accounting for a dynamic effect of 0.05% compared to the same percentage variation in the sector employing population.

Regarding the control variables, the compensation variable is the most important one. The other significant control variable is the *dummy* S, which has a negative sign indicating the existence of some delay in the southern region with respect to other regions.

Commercial Services (G-K)

Commercial service sectors show results that would suggest the existence of urbanization economies on the one hand and dynamic economies on the other. The HHI variable coefficient is positive in those three models corresponding to this sectoral group. The positive sign of HHI seems to indicate the existence of urbanization economies. However, the coefficient indicating the importance of market size is not significant. The increase in HHI indicates a lower concentration of economic activity in the group regarding G-K sectors. This fact, in turn, may be due to two reasons. The first refers to an increase regarding diversity in the productive activity, i.e. that all other sectors would have a greater participation in employment. The second reason is that economic activity (measured by employment) would move from the G-K group to another activity sector[11]. In the first situation, the commercial services could be enjoying economies of scale due to the availability of a wide range of differentiated intermediate inputs. It seems unlikely that, in such an environment, an information flow exists as the cause of these economies. In the second situation, however, the concentration of some other activity sector would be the cause for economies of scale,

[11] These two alternatives are derived from the mathematical properties of the function HHI, which increases as the observed sector becomes less relevant (in this case measured with the population employed in the sector), indicating a lower concentration. But, in turn, the rate also increases when the activity is concentrated in some of the other sectors (excluding the interest one), indicating a lower concentration, when in fact the concentration has increased, but in another sector that is not the interest one. To differentiate between these two effects, we could in future work use the Gini concentration index in addition to the HHI, or any functional form that includes both.

the one which would generate supply complementarities and important *spillovers* of information.

The ESP variable presents a positive sign and indicates that there are dynamic economies of scale for all commercial services considered. A 1% variation in the degree of specialization has a positive effect of 0.67% in the value added of sectors G-K.

Regarding the control variables, only the first two, compensation and asset formation are significant. The signs of both are positive as expected, and the effect of compensation is much more relevant than that of the fixed assets as was also expected to occur in the service sector.

Public Administration, Defence and Social Security (L)

Sector L has three results related to returns to scale. The first is some form of urbanization economies, the second is the existence of agglomeration economies, and the third refers to the existence of decreasing returns to scale.

Regarding urbanization economies, these have a positive coefficient and are statistically significant in the third model. The relationship between the population variable in levels and aggregated value per employee in the public administration sector indicate, indeed, urbanization economies, since with the same size of the state apparatus and equal spending (at least in active formation and offsets) the number of people who benefit from products and services in the sector increases. As can happen in other sectors of activity, the diversity of inputs for the development of activity tends to increase in more diverse environments, and public administration itself can benefit from the existence of an important infrastructure and communication channels to improve its provision of services.

The HHI variable shows a negative sign in this sector, which gives strength to the result. There are, therefore, agglomeration economies that show that the more important the public sector is in terms of employment, the greater the aggregate value per person employed in that sector will result. Of course this result could not be extrapolated to any country, but at least in the Netherlands it means that a larger public sector is more efficient. The reason for this can be found in the greater flow of information that circulates within the sector.

The third result is the question of the existence of decreasing returns to scale predicted from the negative coefficient of Ln(TEI). This result implies that, as you increase the average size of local units of government, the efficiency with which each one operates is reduced. This result also seems logical to the extent that public institutions are organized on the basis of a bureaucratic structure, and where the need to keep control in large environments does not allow the level of flexibility that smaller environments are able to maintain.

It should be noted that these results regarding the economies of scale, that we observed for sector L, can only arise due to the technique of OLS regression that allows a change of independent variables while leaving the others constant to determine the effect on the dependent one. In fact the increase of employed population in other sectors must be correlated with the non-concentration of sector L (an increase of HHI). On the one hand, the increase of this population would generate economies of urbanization, but on the other it would also lead to a decentralization of public administration (towards other sectors) reducing the economies resulting from agglomeration. The existence of an optimum concentration level for the sector seems feasible, at least theoretically. The second link between the economies of scale is that the higher concentration of the economy in sector L may be due to an increase in the average size of establishments, which would generate decreasing returns offsetting the positive effect of agglomeration, although this would not necessarily pose a *trade off* between them as in the previous case.

Regarding the control variables, the asset formation is significant, while the compensation variable is only significant in the first two models. The other important control variable is the dummy for the eastern region, indicating some degree of improvement over the other three.

Education, Health, Social and Community Work, and Domestic Work (M-P)

Although this last clustering of sectors can be quite diverse, the R^2 of the suggested models range from 0.69 to 0.72. And two results associated with economies of scale can be observed in them, decreasing returns to scale (internal); and dynamic economies.

The first of these, the internal firm "diseconomies" (negative sign coefficient) retain their statistical significance across all three models. The increase in the average size of establishments in these sectors by 1% would generate a reduction of the 0.15% concerning the added value growth.

As for dynamic economies, the coefficient for the specialization variable shows a value of 0.46 with a statistical significance level of 10% in the latest model. In this case the 1% increase in the specialization level (0.01 increase of ESP_{MP}) would have a positive effect of almost half a percentage point in the added value of all sectors (0.46%).

Regarding the control variables, the only one assuming statistical significance, always 1%, is the compensation variable. The relationship between this variable and the added value is almost one to one, which seems logical to the extent that the activities included in sectors M-P are intensive among the staff. Perhaps in the areas of health, and to a lesser extent education, we might have expected the formation of fixed assets to be relevant. The same would apply for the variables of Education and Research and Development. It is likely that, if we had counted on more disaggregated statistics for these sectors, these variables would have become relevant for at least health and education activities.

Table 2: Results of the estimation of economies of scale (t-ratio in parentheses)

Agriculture, Hunting, Forestry and Fisheries (A + B)

Modelo	Constante	Economías de Escala					Variables de control							R^2
		$POP_T - POP_i$	HHI_i	$\ln(TE_i)$	ESP_i	$\ln(EMP_i)$	$\ln(FAF_i)$	$\ln(COM_i)$	EDU_T	$R\&D_T$	W	E	S	
1	-2.05 (-0.81)	0.00 (0.14)	3.10 (1.68)	-0.36 (-2.14)	11.11 (2.27)	-0.12 (-1.30)	0.17 (0.81)	0.73 (0.99)	-	-	-	-	-	0.63
2	0.19 (0.05)	0.00 (0.81)	3.73 (2.26)	-0.12 (-0.82)	4.61 (1.13)	-0.05 (-0.66)	0.38 (2.15)	0.29 (0.49)	0.03 (2.32)	-0.34 (-4.63)	-	-	-	0.79
3	0.44 (0.22)	0.00 (1.33)	4.27 (2.63)	-0.09 (-0.65)	2.42 (0.61)	0.00 (-0.02)	0.46 (2.69)	0.23 (0.40)	0.02 (1.32)	-0.20 (-1.90)	-0.16 (-2.47)	-0.06 (-1.45)	-0.09 (-1.89)	0.83

Mining, Quarrying and Energy and Water Supply (C + E)

Modelo	Constante	Economías de Escala					Variables de control							R^2
		$POP_T - POP_i$	HHI_i	$\ln(TE_i)$	ESP_i	$\ln(EMP_i)$	$\ln(FAF_i)$	$\ln(COM_i)$	EDU_T	$R\&D_T$	W	E	S	
1	-3.76 -1.37)	0.00 (0.35)	0.64 (0.09)	-0.95 (-3.34)	24.68 (0.71)	0.88 (2.03)	0.03 (0.24)	1.18 (2.42)	-	-	-	-	-	0.74
2	-4.87 (-1.61)	0.00 (0.33)	1.70 (0.22)	-0.95 (-3.23)	41.05 (1.04)	0.81 (1.79)	0.03 (0.23)	1.02 (1.93)	0.05 (0.93)	0.13 (0.42)	-	-	-	0.77
3	-6.19 (-1.83)	0.00 (0.62)	-2.64 (-0.34)	-0.63 (-2.22)	52.61 (1.11)	0.22 (0.38)	-0.09 (-0.65)	1.64 (2.63)	0.13 (1.98)	-0.61 (-1.32)	-0.21 (-0.64)	-0.03 (-0.16)	0.24 (1.05)	0.86

Table 2: Results of the estimation of economies of scale (t-ratio in parentheses)

Manufacturing (D)

Modelo	Constante	Economías de Escala					Variables de control							R^2
		$POP_T - POP_i$	HHI_i	$\ln(TE_i)$	ESP_i	$\ln(EMP_i)$	$\ln(FAF_i)$	$\ln(COM_i)$	EDU_T	$R\&D_T$	W	E	S	
1	-1.61 (-0.31)	0.00 (0.01)	-1.23 (1.14)	0.05 (0.36)	0.84 (1.17)	-0.20 (-3.33)	0.34 (2.83)	1.52 (4.11)	-	-	-	-	-	0.77
2	-1.63 (0.38)	0.00 (0.01)	-1.17 (1.04)	0.04 (0.25)	0.86 (1.16)	-0.18 (-2.57)	0.32 (2.67)	1.55 (3.87)	0.00 (0.68)	-0.03 (0.61)	-	-	-	0.78
3	-1.10 (0.66)	0.00 (0.01)	-1.29 (1.065)	0.06 (0.35)	0.98 (1.09)	-0.21 (-2.33)	0.31 (2.38)	1.42 (2.37)	0.00 (1.32)	-0.06 (-0.97)	0.04 (0.96)	0.03 (0.75)	0.03 (0.75)	0.78

Construction(F)

Modelo	Constante	Economías de Escala					Variables de control							R^2
		$POP_T - POP_i$	HHI_i	$\ln(TE_i)$	ESP_i	$\ln(EMP_i)$	$\ln(FAF_i)$	$\ln(COM$	EDU_T	$R\&D_T$	W	E	S	
1	1.63 (2.70)	0.00 (0.12)	-0.20 (-0.75)	-0.03 (-1.13)	-0.16 (-0.34)	-0-01 (-0.63)	-0.01 (-0.66)	0.69 (4.91)	-	-	-	-	-	0.51
2	1.65 (2.52)	0.00 (0.05)	-0.21 (-0.75)	-0.03 (-0.94)	-0.15 (-0.30)	-0.01 (-0.64)	-0.01 (-0.60)	0.69 (4.69)	0.00 (0.06)	0.00 (0.25)	-	-	-	0.52
3	1.46 (2.02)	0.00 (0.09)	-0.21 (-0.65)	-0.04 (-1.10)	-0.03 (-0.07)	-0.02 (-0.70)	-0.01 (-0.46)	0.72 (4.59)	0.00 (0.44)	-0.01 (-0.53)	0.01 (0.55)	0.00 (0.59)	0.01 (0.92)	0.53

Table 2: Results of the estimation of economies of scale (t-ratio in parentheses)

Construction (F)(cont.)

Modelo	Constante	Economías de Escala					Variables de control						
		$POP_T - POP_i$	HHI_i	$\ln(TE_i)$	ESP_i	$\ln(EMP_i)$	$\ln(FAF_i)$	$\ln(COM$	EDU_T	$R\&D_T$	W	E	S
4	1.90 (2.11)	0.00 (1.41)	0.26 (0.75)	-0.75 (-1.19)	-0.03 (-1.35)	-0-04 (-1.04)	0.00 (-0.01)	0.60 (3.09)	0.00 (0.49)	-0.04 (-1.72)	-0.04 (-0.60)	-0.06 (-1.56)	-0.07 (-1.77)

Modelo	Variables de control	Términos de interacción de Economías de Escala						R^2
	$\ln(AF_i)^2$	$\ln(TE_i)W$	$\ln(TE_i)E$	$\ln(TE_i)S$	$\ln(EMP_i)W$	$\ln(EMP_i)E$	$\ln(EMP_i)S$	
4	-0.01 (-0.20)	-0.02 (-0.52)	0.02 (0.83)	0.04 (1.35)	0.05 (2.54)	0.02 (1.83)	0.02 (1.40)	0.70

Table 2: Results of the estimation of economies of scale (t-ratio in parentheses)

Commercial Services (G-K)

Modelo	Constante	Economías de Escala					Variables de control							R^2
		$POP_T - POP_i$	HHI_i	$\ln(TE_i)$	ESP_i	$\ln(EMP_i)$	$\ln(FAF_i)$	$\ln(COM_i)$	EDU_T	$R\&D_T$	W	E	S	
1	0.72 (0.77)	0.00 (0.05)	1.07 (1.64)	-0.07 (-0.96)	0.42 (1.34)	-0.01 (-0.22)	0.06 (1.60)	0.76 (3.15)	-	-	-	-	-	0.58
2	0.86 (0.89)	0.00 (0.22)	1.49 (1.99)	-0.06 (-0.70)	0.58 (1.69)	-0.02 (-0.55)	0.07 (1.80)	0.73 (2.99)	0.00 (0.92)	0.02 (1.11)	-	-	-	0.60
3	0.60 (0.58)	0.00 (0.14)	1.44 (1.93)	-0.07 (-0.87)	0.67 (1.81)	-0.02 (-0.54)	0.08 (1.82)	0.76 (2.93)	0.00 (0.08)	-0.01 (-0.21)	0.00 (0.07)	0.01 (0.55)	0.02 (1.37)	0.65

Public administration, defense and Social Security (L)

Modelo	Constante	Economías de Escala					Variables de control							R^2
		$POP_T - POP_i$	HHI_i	$\ln(TE_i)$	ESP_i	$\ln(EMP_i)$	$\ln(FAF_i)$	$\ln(COM$	EDU_T	$R\&D_T$	W	E	S	
1	0.41 (0.25)	0.00 (1.43)	-0.59 (-1.74)	-0.05 (-1.90)	0.00 (0.00)	-0.05 (-2.21)	0.17 (7.07)	0.89 (2.08)	-	-	-	-	-	0.80
2	-0.84 (-0.49)	0.00 (1.30)	-0.64 (-1.90)	-0.05 (-1.83)	-0.37 (-0.85)	-0.03 (-1.33)	0.18 (7.71)	1.22 (2.81)	0.00 (0.93)	-0.03 (-1.80)				0.83
3	0.99 (0.53)	0.00 (1.85)	-1.04 (-2.61)	-0.08 (-2.65)	-0.20 (-0.42)	-0.04 (-1.67)	0.17 (6.97)	0.78 (1.64)	0.00 (0.83)	-0.02 (-0.75)	0.02 (1.09)	0.02 (1.75)	0.00 (0.07)	0.86

Table 2: Results of the estimation of economies of scale (t-ratio in parentheses)

Education, Health, Social Work and Community & Home (MP)

Modelo	Constante	Economías de Escala					Variables de control							R^2
		$POP_T - POP_i$	HHI_i	$\ln(TE_i)$	ESP_i	$\ln(EMP_i)$	$\ln(FAF_i)$	$\ln(COM$	EDU_T	$R\&D_T$	W	E	S	
1	-0.40 -1.37)	0.00 (0.35)	-0.06 (0.09)	-0.13 (-3.34)	0.28 (0.71)	-0.01 (2.03)	0.01 (0.24)	1.02 (2.42)	-	-	-	-	-	0.69
2	-0.46 (-0.65)	0.00 (1.04)	-0.06 (-0.28)	-0.13 (-2.86)	0.28 (1.37)	-0.01 (-0.54)	0.01 (0.83)	1.02 (6.84)	0.00 (0.21)	0.00 (0.10)				0.69
3	-0.85 (-1.09)	0.00 (1.37)	-0.09 (-0.35)	-0.15 (-3.09)	0.46 (1.93)	-0.02 (-1.07)	0.01 (0.40)	1.10 (6.68)	0.00 (0.68)	-0-01 (-0.92)	0.01 (1.26)	0.00 (0.62)	0.01 (1.42)	0.72

4.2. Simulation results

The first thing to be done in order to carry out the simulation process is to determine in which sectors of the Dutch economy a natural resource boom could take place. Following the historic events in the country, this shock could fall on the C + E sectors, considering the division we used to quantify the returns to scale.

Concerning the basic assumptions of factor mobility regarding the model of the Dutch disease, if we place our analysis in the short term it is appropriate to maintain the hypothesis of fixed capital. As for the labour mobility, we can base it on the migratory phenomenon between COROP regions, which would not involve any significant inconvenience to those who are willing to move[12].

The model is designed for: a tradable goods sector where the boom occurs (the natural resource sector), an industrial tradable goods sector (industrial or manufacturing sector) and a non-tradable goods sector (services sector). We count on: a natural goods sector, which comprises activity sectors C + E, an industrial sector D[13], several non-tradable goods sectors, including: construction F, education and social and community work M-P, and commercial services G-K[14]. Finally we have one more non-tradable services sector but we consider it separately from the others because of its special characteristics: public administration L.

We have argued that the Dutch disease acts through two effects. *The displacement effect,* which generates a distance between the mobile production factors (labour) and the other sectors towards the booming sector, as a result of the boom in sectors C + E,. Consequently the C + E sector will experience an expansion, while the other sectors: D, F, GK, and M-P[15] will tend to contract. The other effect is *the spending effect:* where the generalized increase in demand due to the positive shock

[12] This assumption implies accepting that specialization patterns that are generated due to the shock will have no effect on the results that we will obtain. Dynamic economies that may arise in the long term due to a reallocation of productive factors because of the boom cannot be included in the analysis.

[13] It should be clarified that the distinction between the natural resource sector and industry is never entirely clear, since many of the economic activities included in the latter may be using primary inputs.

[14] Some of them may have mixed characteristics: non-tradable and tradable.

[15] Even sectors A and B would be affected by a reduction because of the displacement if the shock occurred in C + E as we are assuming. As for sector L, we can assume that it would not be affected since labour mobility in this sector is much more limited than in the rest due to the importance of stability of the employment contracts in the civil service.

leads to higher salaries in all sectors, but only to a price increase in the non-tradable sector. In other words, it will cause a real appreciation of the currency and a further shift of the labour force, from the tradable goods sector towards the non-tradable one. As a result of this effect, the model predicts a reduction in sector D, and a size increase in the sectors F, G-K and M-P. Regarding the public administration two things can happen: if the state gets important income from the exploitation of those sectors affected by the boom, then it is possible to have an expansion of this sector. Given the opposite scenario, sector L could remain more or less constant.

Finally, the effect of the shock results in an expansion of the sectors C + E and in a reduction of the industrial sector D, and has an ambiguous result in the case of all other sectors of the economy. Nevertheless, in order not to remain with this final dilemma, we take as true the hypothesis that considers the final role which would have the intervention of a rentier state. If, as we said above, the Dutch Government obtains a considerable income through the boom, not only an L expansion will occur but also an expansion of all other non-tradable sectors due to higher public spending. Otherwise we will assume that L remains constant and the non-tradable sectors experience a contraction in the activity level[16].

According to the obtained results, sectors C + E do not have any type of externalities, and the only significant coefficient was found to be the internal economies but with opposite sign, i.e. they will show decreasing returns to scale.

So it could not be expected that the displacement of factors will result in an increased output in a way that is more than proportional. Sector D would experience a reduction due to those factors that migrate to other sectors. However, an increase in the employed population in other sectors may generate urbanization economies; which might result in a small contraction having no significant effects on the growth rate of the economy.

Later on we will outline the results when dealing with a non-tradable sector expansion, as well as when dealing with a contraction. If the situation were the first, the expansion would be due to an increase in the public spending. If this is true, as we have

[16] We accept this hypothesis knowing that it is a simplification that allows some analysis. In fact the non-tradable sector may experience an expansion for the sole effect of marginal propensity to consume nontradable goods.

mentioned, as a consequence of urbanization economies and industry agglomeration then sector L has some optimum size considering that the situation in this sector was the one in the long-term until the moment of shock, i.e. that is until there was some equilibrium between these two forces. An increase in spending would tend to over-size the public sector, leading to reductions in the growth rate due to the loss of urbanization economies (superior to the agglomeration economies). As for sectors F and M-P, in addition to the expected proportional increase resulting from its expansion, we would have no records regarding economies of scale that could generate a higher growth. As for sector G-K, besides the proportional increase due to increased activity, a mixed effect would occur: the expansion of other sectors would cause an increase due to urbanization economies, while employment growth within this sector would have the opposite effect.

The second possibility is that the non-tradable sector experiences a contraction. In this case we said that we could maintain the hypothesis that L would remain constant. M-P and F sectors would experience the contraction due to the decrease in employment, but would not be affected by any type of externality. While G-K urbanization economies would again experience a mixed situation, this time the decrease of their own employment and the C + E increase would have a positive effect, but the reduction in employment in the other non-tradable sectors would have the opposite effect.

From this point of view, it seems feasible that a natural resource boom causes a reduction in the economy growth rate. However this is not so clear, since there are opposite effects that could result in both a decrease or an increase in growth rate. To eliminate this ambiguity it would be necessary to consider the quantitative effect of these variations.

To carry out the quantitative analysis of the shock we take as a starting point both situations: non-tradable goods sectors experience an expansion or these sectors are reduced. However, it is also interesting to know the effect derived from the expansion of sectors C + E (natural resources) at the expense of sector D (industrial). For this reason we will add a third situation where the non-tradable sectors do not experience any changes in their normal activity levels.

We outline three different boom intensities to get more diverse information. To carry out this task we assume that the external shock can lead to increased employment in these sectors in the order of 1%, 10% or 20%. And, finally, we add two possible cases: in the first there are almost no rigidities concerning the labour movement (it is considered that 1% of the labour force is still in the original sector); in the second there are greater rigidities regarding the job market (this situation is more real, and assumes that 75% of employees have some fixed character in the short term). This multiplicity of situations and possibilities results in 18 possible scenarios, plus an initial scenario considered as base, being the results of the statistics for the years 1995, 2006 and 2007.

As the number of variables that can be used is limited, we have selected a single group of non-tradable goods sectors to simulate the effects of expansion and contraction. The M-P group (Education, Health, Social Work and Community, and Domestic Work) seems the most suitable one to be incorporated into the analysis, since it generates more pronounced quantitative results when the activity volume increases as well as when it decreases[17].

Table 3 summarizes the results obtained from the maximization process of the proposed model. The optimal outcome that the Dutch economy would have in each of the scenarios, and under the assumptions that have been explained previously can be observed.

Table 3: Summary of the main results from simulations

Base Scenario: average growth rate (1995 - 2007)				3,95%
Alternative Scenarios				
Labour market Rigidities	Change in Sectors M-P	Sectors C+E Expansion		
		1%	10%	20%
1%	None	3,88%	3,27%	2,88%
	Expansion	9,73%	9,12%	8,60%
	Contraction	3,81%	2,54%	1,47%
75%	None	3,88%	3,26%	2,61%
	Expansion	4,22%	3,59%	2,95%
	Contraction	3,81%	2,54%	1,25%

Source: Elaborated by the author.

[17] Expansion tests have been carried for of all non-tradable sectors to identify the most likely to generate significant increases and decreases in growth rates. The results are available upon reader´s request.

The first thing you may notice when comparing the expansion of the natural resources sector, without the involvement of other sectors, under a situation of perfect mobility, is that the rate of economic growth would be reduced (with respect to the base scenario). If we observe from left to right the first row of scenarios in the table, we can also note that the larger the displacement of factors from industry sectors towards those sectors that benefited from the boom, the lower the rate of growth of aggregate value per worker. These results are in perfect harmony with the existence of *the natural resource curse derived from the Dutch disease dynamics.*

The following line shows the results of an expansion, first the sectors C + E and then sectors M-P at the expense of the industry sectors. Growth rates are higher compared to that situation where the natural resource sector is the only one increasing. These expansion scenarios have the characteristic that the only restriction on the movement of factors is the lower limit of 1% that must remain fixed in sector D. Therefore the potential solutions must be equal to or better than the situation without M-P expansion. As a result of the maximization process, and given the low percentage of the labour force that must remain fixed, the COROP regions with lower productivity in the industrial sector have transferred labour force to COROP regions with higher productivity in the M-P sector group. In this way the most productive regions in sector D can continue operating, the most productive regions in M-P sectors can benefit from the transfer by increasing the rate of global growth, and the decrease due to the expansion of C + E can be compensated. We might therefore anticipate that, given the existence of a flexible labour market, allowing the movement of the workforce from low-productivity regions into high-productivity regions, and given the expansion of certain non-tradable goods sectors with potential growth, the *natural resource curse* might not take place.

The next line of scenarios simulates the existence of a contraction in M-P sectors (in addition to the pertinent expansion of C + E). The decrease in employment concerning the non-tradable sector has also, as a counterpart, increased employment in the booming sector. In this case, as the process of maximizing the growth rate would not allow "voluntary" contraction of the M-P sector to make C + E grow, the simulation made assumes that the new “forced” expansion of C + E has the same relative value as the first expansion. The first cell in the third line indicates an initial expansion of the natural resources sector of 1% at the expense of the industry sector, and a second expansion of 1% but at the expense of the non-tradable sector.

The same criterion is applied to all cases in which contractions occur in the non-tradable sector. In these cases we observe that both the first C + E expansion (at the expense of industrial employment), as the second one (at the expense of the non-tradable sector) have the same effect, a reduction in the growth rate. And as both effects are negative, generating growth rates become increasingly lower as most of these factors move towards C + E. We can state that, in the event that a contraction occurs in some of the non-tradable goods sectors (the most productive ones) as a result of the boom, *the curse of natural resources* tends to accentuate the generating growth rates to being even lower

The last three lines attempt to illustrate a more real scenario in the short term, where there are labour market rigidities that prevent the free movement of the labour force. For this reason, as we said, it is assumed that 75% of the workforce has a fixed character in the sector and region to which they belong. Only 25% can move to other sectors of the economy.

The first box in the fourth line of the scenario adopts the same result as the first proposed alternative scenario (where the rigidities were barely 1%). This is because the expansion of the 1% of C + E is not large enough to require a significant endowment of the workforce, allowing less productive regions to transfer staff from its industrial sector into sectors C + E, while the most productive regions in the industrial sector can continue operating. Since the solution of a growth rate of 3.81% (with 1% rigidities) continues to be feasible in a scenario with tighter restrictions (75% rigidity), the optimal solution will be the same. However, in the two following boxes the results obtained show that more rigid restriction in the labour market starts to be operational, and the growth rates (3.26% and 2.61%) are lower than in the scenarios with 1% rigidity (3.27% and 2.82%).

What happens in the latter two cases is that the expansion of 10% and 20% of the natural resources sector is so large that it begins to absorb the labour force not only from the least productive regions in sector D but also from the most productive ones causing, ultimately, a decrease in the growth rate. In situations where labour market rigidities equally affect regions independently of their productiveness (and even more when the least productive regions have higher rigidities), the natural resource curse has more pronounced negative effects because it does not allow less productive regions to be the ones that experience the process of de-industrialization, but this does occur even in regions with higher productivity.

The fifth line of the table presents some results already known. Firstly, when there is an expansion of certain non-tradable sectors the growth rate improves. Second, the larger the expansion of C + E, the lower is the growth rate. And third, the higher the labour market rigidity, the more the growth rate decreases. However, this last fact is even more relevant in the light of the numerical results that have been obtained.

The last two growth rates of the fifth row are lower than the one in the base scenario. This implies that if expansion of C + E is large enough (in this case from 10%) and labour market rigidities are high enough (in this case 75% of the regular workforce), not even the expansion of the most productive non-tradable sector can reverse *the curse of natural resources*. This is because the potential growth of M-P is reduced by the lack of labour force, which, on one hand, has been absorbed by C + E and, on the other hand, is employed in low productivity regions in the industrial sector due to the rigidities in the labour market

Finally, the last line of the table illustrates the three worst possible scenarios. The last one, with the rate of 1.25% is where all the negative factors we have seen converge: maximum expansion of C + E at the expense of D, increased labour market rigidities (75%) and contraction of the M-P sectors, and, a further expansion of C + E.

Finally, we may add that in a scenario of perfect (or almost perfect) mobility concerning the labour factor, we found that in 66% of the cases the curse of natural resources would occur. In a scenario of labour rigidities, we found that in 89% of the cases the curse of natural resources would take place. Of course these probabilities are not absolute but rather dependent on the sector productivity, and on all variables that we have outlined when dealing with the econometric models, i.e., the quantitative importance (magnitude) of the external shock in the natural resource sector, and the rigidities of labour markets.

5. Conclusions

The aim of this paper is to explain the curse of natural resources through an alternative methodology applied to the Dutch case. To this end, an empirical procedure in two stages has been put forward in such a way that we proceed first to the measurement of returns and externalities for each sector of economic activity, generally defining a production function and then translating it into a concrete econometric specification. As an innovative approach in the second stage, we present a model of nonlinear optimization that under the dynamics of the Dutch disease, in the appropriate scenario and with the results obtained from regressions, is able to prove *the curse of natural* resources for a case study.

The results achieved from regressions carried out and from the optimization model indicate that the sector of Agriculture, Forestry, Hunting and Fishing shows urbanization economies where the size of the market could be playing a key role for these economies. The other natural resources sectors including Mining, Energy and Water do not exhibit economies of scale but decreasing returns to scale within the companies themselves. The industrial goods sector experiences urbanization economies, and apparently "diseconomies" of dynamic scale, whose particular results can be explained by the lack of more disaggregated information. For the construction sector the results indicate the existence of dynamic economies for the east and west regions. Commercial services also exhibit dynamic economies and urbanization economies. The public sector is considered a special case of combination between internal decreasing returns and urbanization and agglomeration economies, which leads to the idea that in the long run there may be an optimal concentration level for that sector. Regarding the sectors of Education, Health and Social and Community Work, we note that they exhibit decreasing returns concerning companies, and dynamic economies derived from specialization patterns of 10 years ago.

Subsequently a qualitative analysis is carried out, leaving open the possibility of the existence of the natural resources curse though not leading to a clear conclusion in this regard. Using the nonlinear model of optimization, the main conclusions drawn from the Dutch case quantitative analysis were: (i) the natural resource curse is a feasible phenomenon; empirically speaking, the greater the expansion of the natural resources sector, the lower the growth rate of added value per capita of the economy will result; (ii) the expansion of those non-tradable sectors of high productivity (which depends on sectoral dynamics) can alleviate and reverse the curse, that is, they can increase growth rates; (iii) a contraction of the same non-tradable sectors has the opposite effect; (iv) a higher labour market rigidity results in a lower rate of economic growth, and finally; (v) a combination of labour rigidities and pronounced expansion concerning the natural resource sector will lead to reduced growth rates, even when an expansion of the most productive non-tradable sectors is taking place.

Concerning future research on this matter, it would be interesting to continue with a greater industrial and regional disaggregation, in order to increase the explanatory power of the proposed econometric models. It would also be relevant to incorporate into the optimization model the effect of the initial shock, not just the labour movement, and it would also be advisable to extend the model for several periods and include dynamic economies as well as specialization patterns arising from the external shock itself. Finally, it would be a good idea to integrate a model that simulates the process of real appreciation and the economic sector response to the resultant changes, as well as to incorporate data of elasticity regarding the labour factor. In this way, more realistic scenarios can be raised in terms of labour market rigidities, and of expansions of the booming sector as well as the contraction / expansion of other sectors.

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Appendix

Table 1: Regions, Provinces and COROP Regions

Regions	Provinces	COROP Regions
Noord-Nederland	Groningen	Oost-Groningen
		Delfzijl e.o
		Overig Groningen
	Friesland	Noord-Friesland
		Zuidwest-Friesland
		Zuidoost-Friesland
	Drenthe	Noord-Drenthe
		Zuidoost-Drenthe
		Zuidwest-Drenthe
Oost-Nederland	Overijssel	Noord-Overijssel
		Zuidwest-Overijssell
		Twente
	Gerlderland	Veluwenhem
		Achterhoek
		Aggl.Arnhem/Nijmegen
		Zuidwest-Gelderland
	Flevoland	Flevoland
West-Nederland	Utrecht	Utrecht

	Noord-Holland	Kop van Noord-Holland
		Alkmaar en omgeving
		Ijmond
		Agglomeratie Haarlem
		Zaanstreek
		Groot-Amsterdam
		Het Gooi en Vechtstreek
	Zuid-Holland	Agglomeratie Leiden en bollenstreek
		Agglomeratie's Gravenhage
		Delft en Westland
		Oost-Zuid-Holland
		Groot-Rijnmond
		Zuidoost-Zuid-Holland
	Zeeland	Zeeuwsch-Vlaanderen
		Overig Zeeland
Zuid-Nederland	Noord-Brabant	West-Noord-Brabant
		Midden-Noord-Brabant
		Noordoost-Noord-Brabant
		Zuidoost-Noord-Brabant
	Limburg	Noord-Limburg
		Midden-Limburg
		Zuid-Limburg

Table 2: SITC classification

Actividades Económicas			
A	Agriculture, forestry and fishing	K	Financial institutions
B	Mining and quarrying	L	Renting, buying and selling of real estate
C	Manufacturing	M	Consultancy, research and other specialised business services
D	Electricity, gas, steam and air conditioning supply	N	Renting and leasing of tangible goods and other business support services
E	Water supply; sewerage, waste management and remediation activities	O	Public administration, public services and compulsory social security
F	Construction	P	Education
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	Q	Human health and social work activities
H	Transportation and storage	R	Culture, sports and recreation
J	Information and communication	S	Other service activities

Fuente: Datos CBS (Statistics Netherland) - Elaboración propia.

Variables from CBS (Statistics Netherland)

Gross value added: Value added at basic prices by industry is equal to the difference between output (basic prices) and intermediate consumption (purchasers' prices).

Compensation of employees: Compensation of employees is the total renumeration paid by employers to their employees in return for work done. Employees are all residents and non-residents working in a paid job. Managing directors of limited companies are considered to be employees; therefore their salaries are also included in the compensation of employees. The same holds for people working in sheltered workshops. Compensation of employees is distinguished between wages and salaries and employers' social contributions.

Labour input of employees: Labour input of employees is defined as the number of full-time equivalent jobs. Part-time jobs are converted to full-time jobs. For employees a full-time equivalent job is the Annual contractual hours considered full-time in that branch of industry.

Fixed capital formation: Fixed assets are produced tangible or intangible assets that are used in the production process for more than one year. The table reflects the total gross fixed capital formation from production and imports by industry (ownership criterion) and type of asset.

Local unit: Each individual space, area or complex of buildings or areas used by an enterprise for its activities. Each enterprise has at least one location. In case there are more locations of an enterprise located in the same 6-digit postal code (street-level), all locations belong to the same local unit.

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